Traindl-consult

Environmental technology – Quality management – Occupational safety management

Tel.: 0660 / 165 32 43 Email: Traindl@traindl-consult.at Web: http://www.traindl-consult.at

Appraise

to

Carbon dioxide measurements of the air under MNS masks

Client: Initiative #AUSTRIAisFREE?
4020 Linz
represented by Ms. Edith Brötzner

Scope of the report: 12 text pages

Project management: Ing. Dr. Helmut Traindl

Editing: Ing. Dr. Helmut Traindl

Project Number: 303

Vienna, November 6, 2020

Table of contents

1 Summary

On September 8, 2020, the engineering firm "Traindl-consult" conducted measurements of carbon dioxide concentrations under face masks on three test subjects. The tests were documented in a video and made available to the general public via online distribution on September 11, 2020. This report documents the results of the measurements and their assessment in detail in written form. The video, which can be viewed at https://vimeo.com/457543475 is visible, is part of the report.

The continuous measurements, each lasting a few minutes, showed increased carbon dioxide readings under the MNS masks in a concentration range of approximately 3 - 5 vol.% at a constant level in all test subjects.

Due to the small sample size of three subjects, the measurements presented here are merely random samples and therefore by no means correspond to a study, which would naturally require a much more complex study. However, the results confirm Dr. Butz's 2004 study, which found that carbon dioxide from exhaled air accumulates beneath the face mask and is subsequently rebreathed.

During inhalation, the carbon dioxide in the exhaled air, which has accumulated under the MNS mask due to the congestion effect (“dead space volume” under the MNS mask), is rebreathed. Dilution occurs when this air from the interior of the mask, which is significantly contaminated with carbon dioxide, is mixed with atmospheric air during inhalation. The mixing ratio depends, among other things, on the mask size, mask type, size of the inhaled volume, and breathing frequency. Rough estimates for adults show a carbon dioxide concentration in the inhaled air between 0.8 vol.% (equivalent to 8,000 ppm) and 1.3 vol.% (equivalent to 13,000 ppm). For adolescents and children,

Due to the different ratio of “dead space volume” under the MNS mask to inhalation volume, higher carbon dioxide concentrations in the ultimately inhaled air can be expected compared to adults.

Due to the exceedance of the legal limits (Limit Values Ordinance 2020) and the guideline values for indoor air (equivalent to inhaled air) recommended by the Federal Ministry of Agriculture, Forestry, Environment and Water Management in the "Guideline for the Assessment of Indoor Air - Carbon Dioxide as a Ventilation Parameter," health impacts are to be expected. In my opinion, there is an imminent danger, especially in schools. My recommendation is therefore to immediately suspend the mandatory wearing of masks and make them voluntary.

Dr. Helmut Traindl

Dr. Helmut Traindl

Vienna, November 6, 2020

Allgemein beeideter und gerichtlich zertifizierter Sachverständiger
Ing. Dr.
Helmut Traindl
Fachgebiete
06.01 06.11 06.20
06.30 06.60 06.70

2 Introduction

2.1. Client

Initiative #AUSTRIAisFREE
4020 Linz

Represented by Ms. Edith Brötzner

2.2. Contractor

Traindl-consult

Ing. Dr. Helmut Traindl
Hertha Firnbergstraße 14
1100 Vienna

UID: ATU 68478300

2.3. Reason and mandate

Due to the mandatory wearing of masks in public indoor spaces, as mandated by current law, the study aimed to investigate whether carbon dioxide from exhaled air accumulates under the face mask and is subsequently rebreathed. The measurements conducted were intended to review and, if necessary, verify the studies conducted by Dr. Butz, which were published in her dissertation at the Technical University of Munich. Dr. Butz's dissertation is available for download at https://mediatum.ub.tum.de/doc/602557/602557.pdf .

The assignment also includes the assessment of the measurement results from a current perspective.

The investigations were documented in the form of a video. The video with the measurement results and a first interpretation was distributed on 11 September 2020 via the
Internet made accessible to a wider public.

This report documents the results of the measurements and their assessment in written form. The video, which can be viewed at https://vimeo.com/457543475 , is part of the report.

3 Measurement methodology

3.1 Measuring device

Gas analyzer Biogas 5000 (Geotech)

measuring device	Gasanalysator BM 5000
Manufacturer	Geotech
Measuring range / detection limit	Methane: 0 – 100 Vol.% / 0.1 Vol.% Carbon dioxide: 0 – 100 vol.% / 0.1 vol.% Oxygen: 0 – 25 vol.% / 0.1 vol.%
Display accuracy	Methan: 0,1 Vol.% Carbon dioxide: 0.1 vol.% Oxygen: 0.1 vol.%
Sensor Type	Methan: IR-Sensor Carbon dioxide: IR sensor Oxygen: electrochemical sensor
response time	Methan: < 10 sec. Carbon dioxide: < 10 sec. Oxygen: < 20 sec.
Operating temperature	-10 °C to +50 °C
Extraction power, integrated Pump	550ml/min.

The concentration of carbon dioxide was relevant for the measurements in question.

Note: In everyday language, the term "carbon dioxide" is used. The chemically correct name, which is also used in the 2020 Limit Values Ordinance and the BMLFUW Indoor Air Quality Guideline is “carbon dioxide”.

Quality assurance:

The gas analyzer is delivered as a calibrated device by the manufacturer and is ready for use for air measurements upon receipt. The parameters methane, carbon dioxide, oxygen, and hydrogen sulfide are regularly checked with test gases to ensure the accuracy of the displayed measured values. If the tolerance range is exceeded, the measuring device is immediately recalibrated. Typically, no significant changes in the sensitivity of the detectors used in the measuring device can be detected. The readings remain constant over the long term, and recalibration is rarely necessary.

The measuring system is tested with calibration gases the day before the measurements to ensure the accuracy of the displayed measured values and to check for the necessary tightness.

Once a year, an external inspection and maintenance of the measuring device is carried out by the manufacturer's representative.

3.2 Carrying out the measurements

Datum: 08.09.2020

Location: Office of the company “Ing. Dr. Helmut Traindl”, Traindl-consult
(Engineering office for technical environmental protection, technical chemistry and earth sciences, generally sworn and court-certified expert,
Safety officer.).
1100 Wien, Hertha Firnbergstraße 14

Time: 13:30 – 14:30

Participant: Ing. Dr. Helmut Traindl (Traindl-consult)
Ms. Edith Brötzner (Initiative “#Austriaisfree”)
Mrs. Valentina Brötzner (daughter of Mrs. Brötzner)

Experimental procedure / experimental setup:

After putting on the face mask, the test subject positioned a tube underneath the face mask. The air was then extracted at 0.55 l/min from beneath the face mask, ensuring that the suction occurred in the inhalation/ exhalation area between the mouth (upper lip) and nose.

Test subjects / type of mouth and nose protection mask used:

test subject	Alter	Art Mouth and nose protection mask	Notes
Ms. Valentina Brötzner	13	Self-sewn MNS mask	Fresh, not yet used
Ms. Edith Brötzner	36	Commercially available MNS mask	Fresh, straight from the packaging
Dr. Helmut Traindl	65	Commercially available MNS mask	Already used several times, total maximum 30 min.

Duration of the experiments: approx. 5 minutes each.

4 Investigation results

All measurement results are summarized in the following overview.

test subject	Alter	Carbon dioxide	
Ms. Valentina Brötzner	13	3.4 Vol.% - 5.0 Vol.%	34.000 ppm – 50.000 ppm
Ms. Edith Brötzner	36	2.8 Vol.% - 3.6 Vol.%	28.000 ppm – 36.000 ppm
Dr. Helmut Traindl	65	4.2 Vol.% - 5.0 Vol.%	42.000 ppm – 50.000 ppm

The first elevated carbon dioxide concentrations were detected just a few seconds after the measurements began. During the period prior to this, the atmospheric air was extracted by the measurement system, primarily the suction hose. The continuous measurements, each lasting several minutes, showed elevated carbon dioxide readings in a concentration range of approximately 3-5 vol.% at a constant level in all test subjects (measurement acquisition interval of approximately 1 second).

Previously conducted control tests without an MNS mask showed only minimal carbon dioxide concentrations in the measuring range in question.

Due to the small sample size of three subjects, the measurements presented here are merely random samples and therefore by no means correspond to a study, which would naturally require a much more complex study. However, the results confirm Dr. Butz's 2004 study, which found that carbon dioxide from exhaled air accumulates beneath the face mask and is subsequently rebreathed.

A similar self-experiment by Mr Dipl. Ing. should also not go unmentioned.
Dr. Klaus Pelikan. Here, too, high carbon dioxide concentrations were detected under the MNS mask. The experiment is documented in a video published online and available at https://www.youtube.com/watch?v=9exIgkgp11s is visible.

5 Assessment

Carbon dioxide concentration under the MNS mask

The carbon dioxide concentrations detected under the MNS mask are significantly higher than the statutory workplace exposure limits (MAK values) specified in Austria.
(Limit Values Ordinance 2020, Annex I/2020, page 59).

	MAK values Carbon dioxide (carbon dioxide)		Assessment period
Daily mean (DMW)	5.000 ppm	0.5 vol. %	8 hrs/day, 40 hrs/week
Short-term value (STV)	10.000 ppm	1.0 Vol. %	instantaneous value 60 minutes, max. 3 times per shift

The measurement results show the backflow of exhaled air through the MNS masks and the resulting accumulation of carbon dioxide-contaminated air under the MNS masks (dead space volume).

Carbon dioxide concentration in the inhaled air when wearing an MNS mask

During inhalation, the carbon dioxide in the exhaled air, which has accumulated under the MNS mask due to the congestion effect (“dead space volume” under the MNS mask), is rebreathed. Dilution occurs when this air from the interior of the mask, which is significantly contaminated with carbon dioxide, mixes with atmospheric air during inhalation. The mixing ratio depends, among other things, on the mask size, mask type, size of the inhaled volume, and breathing frequency. Rough estimates for adults show a carbon dioxide concentration in the inhaled air of between 0.8 vol.% (equivalent to 8,000 ppm) and 1.3 vol.% (equivalent to 13,000 ppm). For adolescents and children, due to the

Due to the different ratio of “dead space volume” under the MNS mask to inhalation volume, higher carbon dioxide concentrations in the ultimately inhaled air can be expected compared to adults.

Assessment based on current occupational health and safety legislation

In summary, the concentration of carbon dioxide in the air that is ultimately inhaled when wearing an MNS mask can be assessed as follows:

According to the present studies, the inhaled carbon dioxide concentrations when wearing an MNS mask are above the maximum workplace concentration (daily average value) of 5,000 ppm (0.5 vol%) legally prescribed in the 2020 Limit Values Ordinance.

Depending on the mask type, size, inhalation volume, and respiratory rate, the short-term value of 10,000 ppm, corresponding to 1.0 vol.%, can be reached or even exceeded. This short-term value is defined as an instantaneous value and must not be exceeded at any time.

are exceeded (Limit Values Ordinance 2020, Section 4, Paragraph 4).

Health impairments must therefore be expected.

The specified maximum workplace concentrations (MAK values) apply only to healthy persons of working age. The 2020 Limit Values Ordinance assumes that, if the MAK values are adhered to, the health of employees will generally not be impaired and they will not be unreasonably bothered. However, it also states that in individual cases, particularly for pregnant or breastfeeding employees, even if the MAK values are adhered to, health impairment or unreasonable botheration cannot be ruled out (Limit Values Ordinance 2020, Section 2, Paragraph 2). Accordingly, it can be assumed that this addition also applies to people with pre-existing medical conditions.

Other groups of people (children, young people, non-working adults, sick people and people with pre-existing conditions) are not covered by the requirements of the Austrian Occupational health and safety laws protect against hazardous substances in the room air or in the inhaled air. The assessment of the hazard potential of carbon dioxide in the air for these groups of people is explained in detail in the next section.

It should be noted that the distinction between indoor air in workplaces and inhaled air only became necessary due to the legally mandated mask requirement. Due to the rebreathing of carbon dioxide accumulated under the face mask, the carbon dioxide rebreathed from the dead space of the mask is proportionally added to the carbon dioxide concentration in the indoor air when wearing a face mask.

The legal limits refer to the air in the workplace. It can therefore be assumed that when setting concentration limits (MAK values) for hazardous substances in the air in the workplace, in this case carbon dioxide, the legislator actually meant the air that is inhaled. The legislator also points this out in Section 22, Paragraph 3 of the Workers' Protection Act: "In workrooms, sufficient breathable air must be available, taking into account the work processes and the physical demands of the employees, and the indoor climate must be appropriate for the human organism."

Assessment based on the Guideline for the Assessment of Indoor Air (BMLFUW)

The limit values of occupational health and safety laws apply only to employees, not to the rest of the population (children, adolescents, non-working adults, sick individuals, and individuals with pre-existing medical conditions). For these groups, the "Guideline for the Assessment of Indoor Air – Carbon Dioxide as a Ventilation Parameter" (published by the Indoor Air Working Group at the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW), updated version 2017) can be used to assess the carbon dioxide concentration in the inhaled air while wearing face masks. It can be downloaded from the following link (Indoor Air Guideline Part 7_CO2-1.pdf): https://www.bmk.gv.at/themen/klima_umwelt/luft/luft/innenraum/rl_luftqualitaet.html

This guideline uses carbon dioxide as a ventilation parameter. The key importance of this relatively easy-to-determine indicator, carbon dioxide (CO2), lies in its ability to define concentrations that indicate inadequate indoor air quality.

The BMLFUW guidelines specify the following guideline values and targets for indoor air quality (page 37, Table 7):

Klasse	Beschreibung	Arithmetischer Mittelwert der Momentanwerte für CO_2 [ppm]
Klasse 1	Ziel für Innenräume für den dauerhaften Aufenthalt von Personen	≤ 800
Klasse 2	Richtwert für Innenräume für den dauerhaften Aufenthalt von Personen, in denen geistige Tätigkeiten verrichtet werden bzw. die zur Regeneration dienen	≤ 1000
Klasse 3	Allgemeiner Richtwert für Innenräume für den dauerhaften Aufenthalt von Personen	≤ 1400
Klasse 4	Richtwert für Innenräume mit geringer Nutzungsdauer durch Personen	≤ 5000
Außerhalb der Klassen	Für die Nutzung durch Personen nicht akzeptabel	> 5000

In 2017, at a time when face masks were not yet mandatory, the term "indoor air" was synonymous with inhaled air. In comparison, the carbon dioxide concentration in the inhaled air when wearing face masks is composed of the carbon dioxide concentration in the exhaled air that accumulates under the mask and is rebreathed, and the carbon dioxide concentration in the fresh atmospheric air (mixed during inhalation).

For school-age children and adolescents, this means that the carbon dioxide concentrations recommended in the "Guideline for the Assessment of Indoor Air – Carbon Dioxide as a Ventilation Parameter" are significantly exceeded. Section 5.2 ("Definitions") defines school, classroom, and lecture rooms as indoor spaces where intellectual activities are performed. This corresponds to Class 2. The recommended guideline value is < 1,000 ppm carbon dioxide, corresponding to < 0.1 vol.%.

It should be noted that in a study by the German Federal Environment Agency, a carbon dioxide concentration in the breathing air of > 2,000 ppm (> 0.2 vol.%) is rated as “hygienically unacceptable”.

Due to the significant exceedance, health effects are to be expected, as described in detail in the above-mentioned directive.

Possible health effects of increased carbon dioxide concentrations in the inhaled air:

Due to the exceedance of the legal limit values (Limit Values Ordinance 2020) and the guideline values for indoor air (equivalent to inhaled air) recommended by the Federal Ministry of Agriculture, Forestry, Environment and Water Management in the “Guideline for the Assessment of Indoor Air – Carbon Dioxide as a Ventilation Parameter”, health effects are to be expected.

In the current situation with the mandatory wearing of face masks, the carbon dioxide concentration in the inhaled air is composed of the carbon dioxide concentration in the indoor/outdoor air and the exhaled, carbon dioxide-enriched air that accumulates beneath the face masks. A measurement of the carbon dioxide concentration in the indoor air
Using ambient air alone to determine whether occupational exposure limits or indoor air quality guidelines are being met would be incomplete. The results would not reflect actual exposure conditions.

The "Guideline for the Assessment of Indoor Air – Carbon Dioxide as a Ventilation Parameter" lists the physiological effects of elevated carbon dioxide concentrations (page 26). Acute signs of poisoning at high carbon dioxide concentrations include headaches, dizziness, tinnitus, slowed reflexes, motor restlessness, etc. The Federal Environment Agency (Germany) publication "Health Assessment of Carbon Dioxide in Indoor Air" (Bundesgesundheitsbl -Gesundheitsforschung -Gesundheitsschutz 2008 – 51:1358-)
1369, Springer Medizin Verlag 2008), section 5 “Health effects of carbon dioxide in the air we breathe” documents, among other things, an increase in CNS symptoms such as headaches, fatigue, dizziness and lack of concentration at carbon dioxide concentrations > 1,500 ppm, corresponding to > 0.15 vol. %, in the room air.

Symptoms similar to those described above have been occurring more frequently recently. A connection with the legally mandated mask requirement seems obvious, especially since the tests conducted have demonstrated the accumulation of carbon dioxide-contaminated air under the MNS mask and there is an obvious connection due to rebreathing.

Representative of the many reports from affected pupils, we would like to mention here only the case of a 12-year-old girl who collapsed due to wearing an MNS mask.
The child’s ordeal is documented in a video interview with the child’s mother.
Link: https://www.youtube.com/watch?v=EijsxPN3YtI

Recommendation:

Based on the above, I believe that the Labor Inspectorate, as the competent Austrian authority, has a duty to take appropriate precautionary measures immediately in the interest of employee protection. It should be noted that, according to Section 22, Paragraph 3 of the Occupational Safety and Health Act (Arbeitsschutzgesetz), sufficient, healthy breathing air must be available in work spaces. Due to the mandatory wearing of masks, the changed circumstances (rebreathing of exhaled, carbon dioxide-contaminated air that accumulates under face masks) must be taken into account when comparing these with the statutory workplace exposure limits.

According to Section 2 of the 2020 Limit Values Ordinance, the maximum workplace concentrations have been set so that compliance with them does not impair the health of workers. The current limit value of the 2020 Limit Values Ordinance for carbon dioxide (carbon dioxide)
However, this contradicts the significantly lower guideline values for indoor air recommended by the Federal Ministry of Agriculture, Forestry, Environment and Water Management. The Labor Inspectorate would also be required to clarify this matter.

In the school sector, I see an obligation on the part of the Ministry of Education, the principals and the teachers, as they have a duty of care for all the pupils under their supervision.

Since the carbon dioxide concentrations in the inhaled air recommended in the 2017 guidelines of the Federal Ministry of Agriculture, Forestry, Environment and Water Management are significantly exceeded when wearing face masks, I believe there is an imminent danger. This is confirmed by the increasingly frequent published reports from affected students.

My recommendation is therefore to immediately suspend the obligation to wear masks and make it voluntary.

Regarding the potential protective effect of face masks in containing the spread of viruses, I would like to point out the growing number of scientific publications that provide well-founded evidence that face masks do not provide any protective effect. For example,
To illustrate this point, I would like to cite a recent publication from Thieme, the most renowned publisher of medical science publications. Ines Kappstein: Mouth and nose protection in public: No evidence of effectiveness (Thieme Verlag. CME training, 2020).

Finally, I would like to point out that the current practice of frequent ventilation of rooms, or even constant ventilation during the cold season, can lead to a failure to comply with the requirements of the Workplace Ordinance regarding room temperatures. According to Section 28 of the Workplace Ordinance, the air temperature in workrooms where work involving low physical exertion is performed must be between 19°C and 25°C. This requirement also applies to classrooms in schools.

Dr. Helmut Traindl

.....

Dr. Helmut Traindl

Allgemein beeideter und gerichtlich zertifizierter Sachverständiger
Ing. Dr.
Helmut Traindl
Fachgebiete
06.01 06.11 06.20
06.30 06.60 06.70

Vienna, November 6, 2020